

10 Rec'd PCT/PFU 08 SEP 2004

501/03
(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
25 September 2003 (25.09.2003)

PCT

(10) International Publication Number
WO 03/078789 A1

(51) International Patent Classification⁷: **E21B 43/10**

(21) International Application Number: PCT/GB03/01022

(22) International Filing Date: 11 March 2003 (11.03.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
0206256.0 16 March 2002 (16.03.2002) GB

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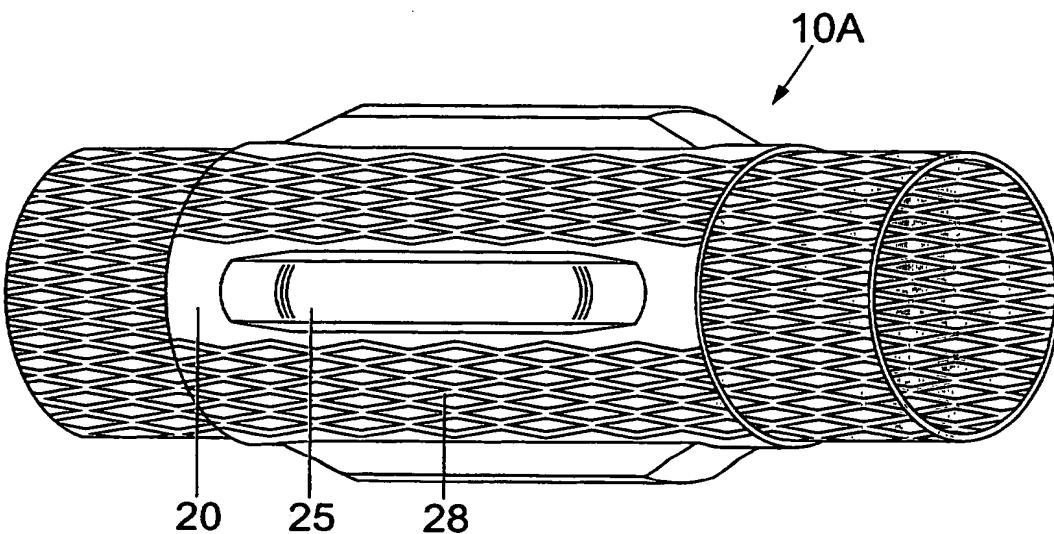
(81) Designated States (national): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: SLOTTED EXPANDABLE CENTRALISER



WO 03/078789 A1

(57) Abstract: This invention relates to a slotted expandable centraliser. In preferred embodiments, the centraliser is adapted to be used in conjunction with slotted casing, and can expand with the casing when an expander cone is propelled through the casing.

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SLOTTED EXPANDABLE CENTRALISER

1

2

3 This Application relates to a centraliser for an oil
4 well tubular.

5

6 Expandable centralisers are known, such as the bow-
7 spring centraliser, which employs resilient bow-
8 springs that are biased into an expanded
9 configuration, and forced into a narrower bore so
10 that the springs deform between the body of the
11 centraliser and the borehole to space the
12 centraliser body apart from the borehole.

13

14 According to the present invention there is provided
15 a slotted expandable centraliser.

16

17 Typically the centraliser has a body with a bore to
18 accept a tubular, and is radially expandable to an
19 expanded configuration on application of a force in
20 a radial direction.

21

1 Preferably, the centraliser has blades that can
2 project radially outward from the body of the
3 centraliser in a non-expanded configuration.

4
5 Preferably, the blades and the centraliser are made
6 from a metal such as steel, and can be of the same
7 thickness.

8
9 Optionally, the blades can project outwardly from
10 the body of the centraliser in the expanded
11 configuration. Alternatively, the blades can change
12 configuration during expansion of the centraliser so
13 that the expanded configuration can have a more
14 uniform radius.

15
16 Preferably, the centraliser has at least two slots.
17

18 Preferably, the slots are longitudinal in the non-
19 expanded configuration, and open to generally
20 diamond-shaped apertures in the expanded
21 configuration. Typically, slots are arranged in
22 longitudinally aligned rows with slots in adjacent
23 rows being axially offset with respect to one
24 another, so that the ends of circumferentially
25 adjacent slots overlap. The rows and the slots
26 themselves need not be axially aligned; this is
27 merely a preferred option.

28
29 Alternatively, the slots are C-shaped in the non-
30 expanded configuration. Other shapes of slots are
31 possible, such as Z-shapes.

1 Preferably, the slots are of uniform dimension, but
2 this is not necessary.

3

4 Optionally, slots are uniformly distributed over the
5 body and the blades. Alternatively, the centraliser
6 has slotted portions circumferentially adjacent to
7 non-slotted portions.

8

9 Optionally, the non-slotted portions include at
10 least one blade.

11

12 Optionally, all of the blades are located in non-
13 slotted portions.

14

15 Typically, the centraliser is made from a material
16 which is capable of plastic and/or elastic
17 deformation.

18

19 Typically the centraliser is adapted to receive an
20 expandable tubular within its bore and is adapted to
21 deform radially with the expandable tubular during
22 expansion.

23

24 According to another aspect of the present
25 invention, there is provided a centraliser assembly
26 comprising a slotted expandable centraliser which
27 has a body with a bore to accept a tubular, and is
28 radially expandable on application of a force in a
29 radial direction to an expanded configuration; and
30 an expandable tubular, located in the bore of the
31 centraliser.

32

1 The tubular can comprise production tubing, casing,
2 liner, drill pipe, screen, perforation guns or any
3 other kind of downhole tubular.

4

5 Preferably, the force to expand the centraliser is
6 provided by an expander device such as an expansion
7 cone being pushed or pulled through the tubular.

8

9 The slots can have a typical length of between 1 and
10 5cm, but this is only optional, and other lengths of
11 slot can be used.

12

13 An embodiment of the invention will now be described
14 by way of example only and with reference to the
15 accompanying drawings, in which:-

16

17 Fig 1A shows a perspective view of a
18 centraliser in an initial, non-expanded
19 configuration;

20 Fig 1B shows the centraliser of Fig 1A in an
21 expanded configuration;

22 Fig 2A shows an alternative embodiment of a
23 centraliser in a non-expanded configuration;
24 and

25 Fig 2B shows the centraliser of Fig 2A in an
26 expanded configuration.

27

28 Referring now to the drawings, Fig 1A shows a steel
29 centraliser 10 in a non-expanded configuration,
30 attached to a slotted expandable steel tubular 12.
31 The slotted expandable steel tubular 12 is well
32 known in the art. Both the centraliser 10 and the

1 tubular 12 have many slots 18, distributed
2 approximately uniformly over the surface.

3

4 The centraliser 10 comprises a body 14 and blades 16
5 which project radially outwards from the body 14 in
6 the non-expanded configuration shown in Fig 1A. In
7 this embodiment the blades 16 are hollow projections
8 formed by pressing the blade shape from the body 14,
9 and are of the same thickness and material as the
10 body of the centraliser 10. The blades 16 each
11 comprise an outer face 16A, side walls 16B and end
12 walls 16C.

13

14 The slots 18 are typically between 1-5cm in length
15 and are arranged in parallel rows that are aligned
16 with the axis of the tubular 12 and the centraliser
17 10. Slots in circumferentially adjacent rows are
18 axially offset with respect to one another, so that
19 the ends of the circumferentially adjacent slots
20 overlap, leaving a web of metal between the ends of
21 axially adjacent slots, and their circumferentially
22 adjacent neighbours. Each slot 18 has a much
23 shorter length than the axial length of the
24 centraliser 10. The slots 18 cover both the body 14
25 and the blades 16.

26

27 All of the slots 18 may be of uniform size and
28 shape, or alternatively, the slots on the blades 16
29 could be differently shaped to the slots on the body
30 14.

31

1 In use, an unexpanded centraliser 10 is fitted onto
2 a string of expandable tubulars 12, with the tubular
3 12 received within the bore of the centraliser as
4 shown in Fig 1A. The string is lowered into a
5 borehole to the depth where expansion of the tubular
6 12 is desired. An expander device (not shown) is
7 then pulled or pushed through the tubular 12. A
8 possible expander device is an expander cone, which
9 is typically pulled/pushed by a hydraulic ram or by
10 fluid pressure. The expander device expands the
11 tubular 12 as it passes through it, and as the
12 tubular expands this expands the centraliser 10
13 located on the outer surface of the tubular 12.

14

15 The largest end of the cone has a greater cross-
16 sectional area than that of the non-expanded
17 centraliser, so as the cone passes the centraliser
18 10, the centraliser 10 experiences a radial
19 expansion force from the expander cone (transmitted
20 via the expandable tubular 12). The two sides of
21 each slot on the centraliser 10 are pushed apart
22 from each other, which widens the slot to the extent
23 permitted by the web of metal between adjacent
24 slots. Thus, the slots change shape; from being
25 long and thin, they become shorter, fatter diamond-
26 shaped apertures. The centraliser radially expands
27 to the size of the widest part of the expander cone.
28 The shape of the final aperture in the expanded
29 centraliser 10 is determined by the size, shape and
30 strength of the web between the slots.

31

1 The blades 16 do not need to expand as much as the
2 body 14 of the centraliser 10 in order to
3 accommodate the expander cone, as they have already
4 been pressed out of the body of the centraliser 10.
5 Thus, the slots of the outer faces 16A may adopt a
6 different shape (e.g. narrower) on expansion as
7 compared with the slots on the body of the
8 centraliser 10. Likewise, parts of the side walls
9 16B and end walls 16C need to expand more than other
10 parts, so there can optionally be a non-uniform
11 pattern of apertures on the expanded centraliser,
12 which can be used to influence the shape and
13 strength characteristics of the expanded centraliser
14 10. After the cone has passed the centraliser 10,
15 the whole centraliser 10 adopts approximately the
16 same inner diameter as the outer diameter of the
17 tubular 12.

18

19 Fig 1B shows the centraliser 10 of Fig 1A in an
20 expanded configuration. The outer faces 16A of the
21 arms 16 have expanded less than the body of the
22 centraliser 10, so that the expanded centraliser 10
23 has a generally uniform radius.

24

25 This embodiment is useful for inserting expandable
26 tubulars such as screens into a borehole, where the
27 blades 16 of the centraliser 10 are required to ease
28 entry of the string into the hole but are not
29 required after expansion of the screen against the
30 borehole wall. With slotted blades as in this
31 embodiment, the centraliser can ease the passage of
32 the string into the hole, reducing friction between

1 the screen and the hole, and spacing the screen from
2 the wall to enhance insertion, and after expansion
3 of the string can virtually disappear against the
4 borehole wall.

5

6 In this embodiment the pattern of the slots on the
7 blades and the body are substantially the same and
8 this can give rise to a non-uniform pattern of
9 apertures on the expanded centraliser. In other
10 embodiments, the pattern or shape of the slots on
11 the blades 16 can differ from the pattern or shape
12 of the slots on the body of the centraliser 10, so
13 as to adopt a more uniform pattern of apertures
14 after expansion of the centraliser 10.

15

16 Fig 2A shows an alternative embodiment of a
17 centraliser 10A. The centraliser 10A has a body 24
18 and longitudinal strips 20, which are not slotted.
19 Blades 25 are positioned on the longitudinal non-
20 slotted strips 20. The rest of the centraliser 10A
21 is slotted, as in the embodiment of Figs 1A and 1B.

22

23 Slots 28 are aligned axially in rows, as in the
24 embodiment of Figs 1A and 1B. Slots 28 in adjacent
25 rows are axially offset with respect to one another.
26 Each slot 28 has a much shorter length than the
27 axial length of the centraliser 10A.

28

29 In use, the centraliser 10A is attached to a portion
30 of slotted pipe and expanded in the same way as the
31 centraliser 10 of Figs 1A and 1B, i.e. by means of
32 an expander cone. The slotted parts of the

1 centraliser 10A expand in the way described above:
2 the two sides of each slot are pushed apart from
3 each other, which widens the slot. The long thin
4 slots become shorter, fatter diamond-shaped
5 apertures.

6

7 The non-slotted strips 20 do not substantially
8 expand (apart from possibly some plastic/elastic
9 deformation). Thus, the non-slotted strips 20 do
10 not change their shape substantially, and the blades
11 25 remain protruding from the expanded body 24.
12 They may become further circumferentially spaced
13 apart from each other, due to the expansion of the
14 slotted parts of the body 24 between the blades 25.
15 Fig 2B shows the centraliser 10A of Fig 2A in an
16 expanded configuration.

17

18 This embodiment is suitable for expandable casing
19 strings that still require a centraliser function
20 after expansion, for example to provide an annulus
21 for cement, or to wash out debris or other material
22 from the well after insertion of the casing.

23

24 It should be noted that it is possible to provide
25 some embodiments with intermediate properties, for
26 example a slotted body and blades with comparatively
27 fewer slots, so that the blades can expand less than
28 the body, and a small blade structure is left after
29 expansion.

30

31 Modifications and improvements can be incorporated
32 without departing from the scope of the invention

1 Claims

2

3 1. A slotted expandable centraliser.

4

5 2. A centraliser as claimed in claim 1, having a
6 body with a bore to accept a tubular, and being
7 adapted to expand radially from a non-expanded
8 configuration to an expanded configuration.

9

10 3. A centraliser as claimed in claim 2, wherein
11 the slots are longitudinal in the non-expanded
12 configuration and diamond-shaped in the expanded
13 configuration.

14

15 4. A centraliser as claimed in claim 2 or claim 3,
16 being adapted to receive an expandable tubular and
17 adapted to deform radially with the expandable
18 tubular upon expansion of the tubular.

19

20 5. A centraliser as claimed in any of claims 2 to
21 4, wherein the centraliser has at least one blade
22 that projects radially outward of the body in the
23 non-expanded configuration.

24

25 6. A centraliser as claimed in claim 5, wherein
26 the at least one blade projects radially outward of
27 the body in the expanded configuration.

28

29 7. A centraliser as claimed in claim 5 or claim 6,
30 wherein the at least one blade is adapted to change
31 configuration during expansion of the centraliser.

32

1 8. A centraliser as claimed in claim 5 or claim 6,
2 wherein the at least one blade is adapted to retain
3 its configuration during expansion of the
4 centraliser.

5

6 9. A centraliser as claimed in any of claims 5 to
7 8, wherein the at least one blade has the same
8 thickness as the body.

9

10 10. A centraliser as claimed in any preceding
11 claim, having slotted portions circumferentially
12 adjacent to non-slotted portions.

13

14 11. A centraliser as claimed in claim 10 when
15 dependent on any of claims 5 to 9, wherein the at
16 least one blade is located in a non-slotted portion.

17

18 12. A centraliser as claimed in any of claims 1 to
19 9, wherein the slots are uniformly distributed over
20 the centraliser.

21

22 13. A centraliser as claimed in any preceding
23 claim, wherein the slots are arranged in
24 longitudinally aligned rows with slots in adjacent
25 rows being axially offset with respect to one
26 another so that the ends of circumferentially
27 adjacent slots overlap.

28

29 14. A centraliser as claimed in any preceding
30 claim, wherein the slots are of uniform dimension.

31

1 15. A centraliser as claimed in any preceding
2 claim, being adapted to deform plastically.

3

4 16. A centraliser as claimed in any preceding
5 claim, being adapted to deform elastically.

6

7 17. A centraliser as claimed in any preceding
8 claim, being a casing centraliser.

9

10 18. A centraliser assembly comprising a slotted
11 expandable centraliser which has a body with a bore
12 to accept a tubular, and is radially expandable from
13 a non-expanded configuration to an expanded
14 configuration; and an expandable tubular, located in
15 the bore of the centraliser.

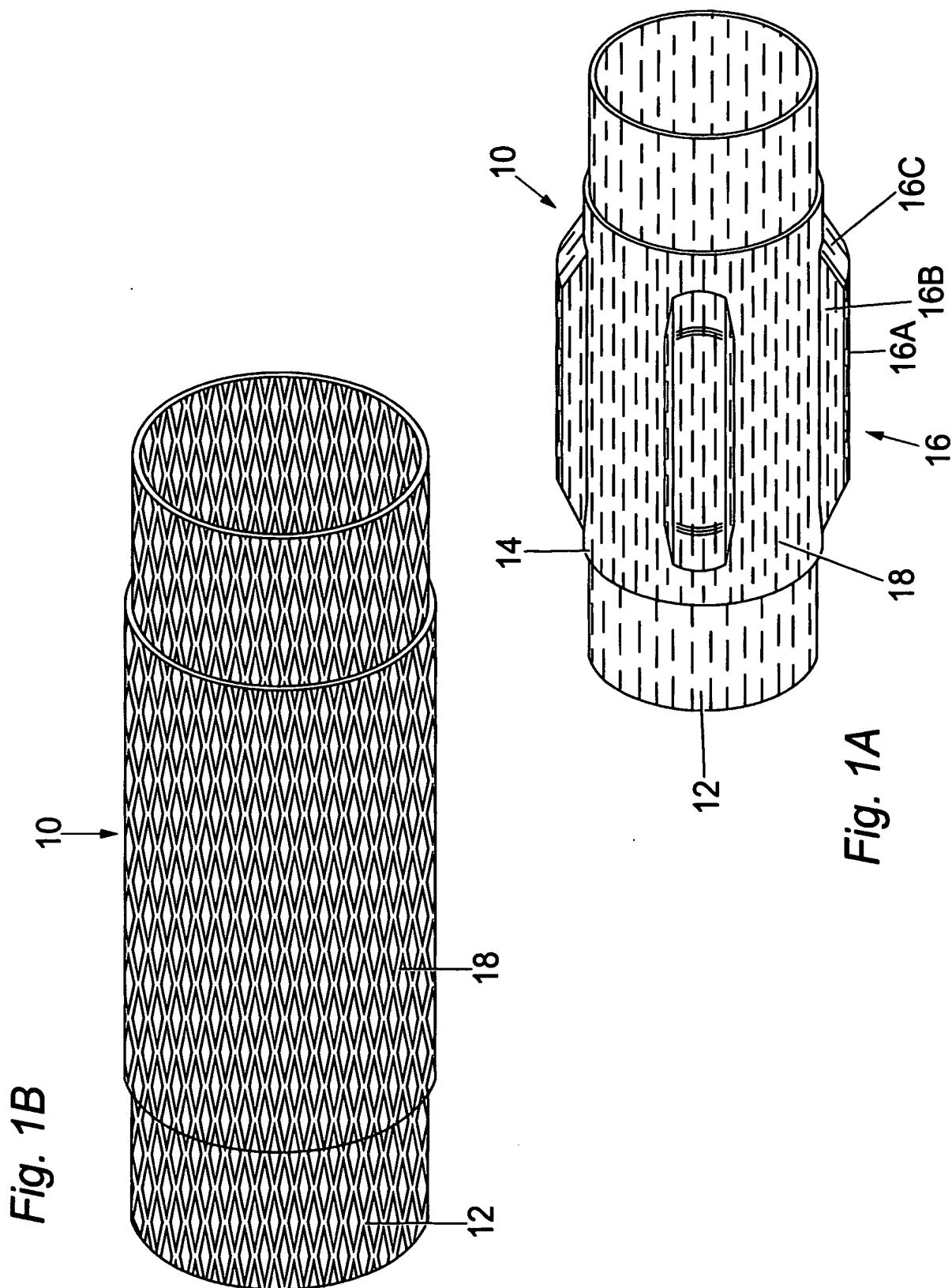
16

17 19. An assembly as claimed in claim 18, wherein the
18 centraliser is a casing centraliser.

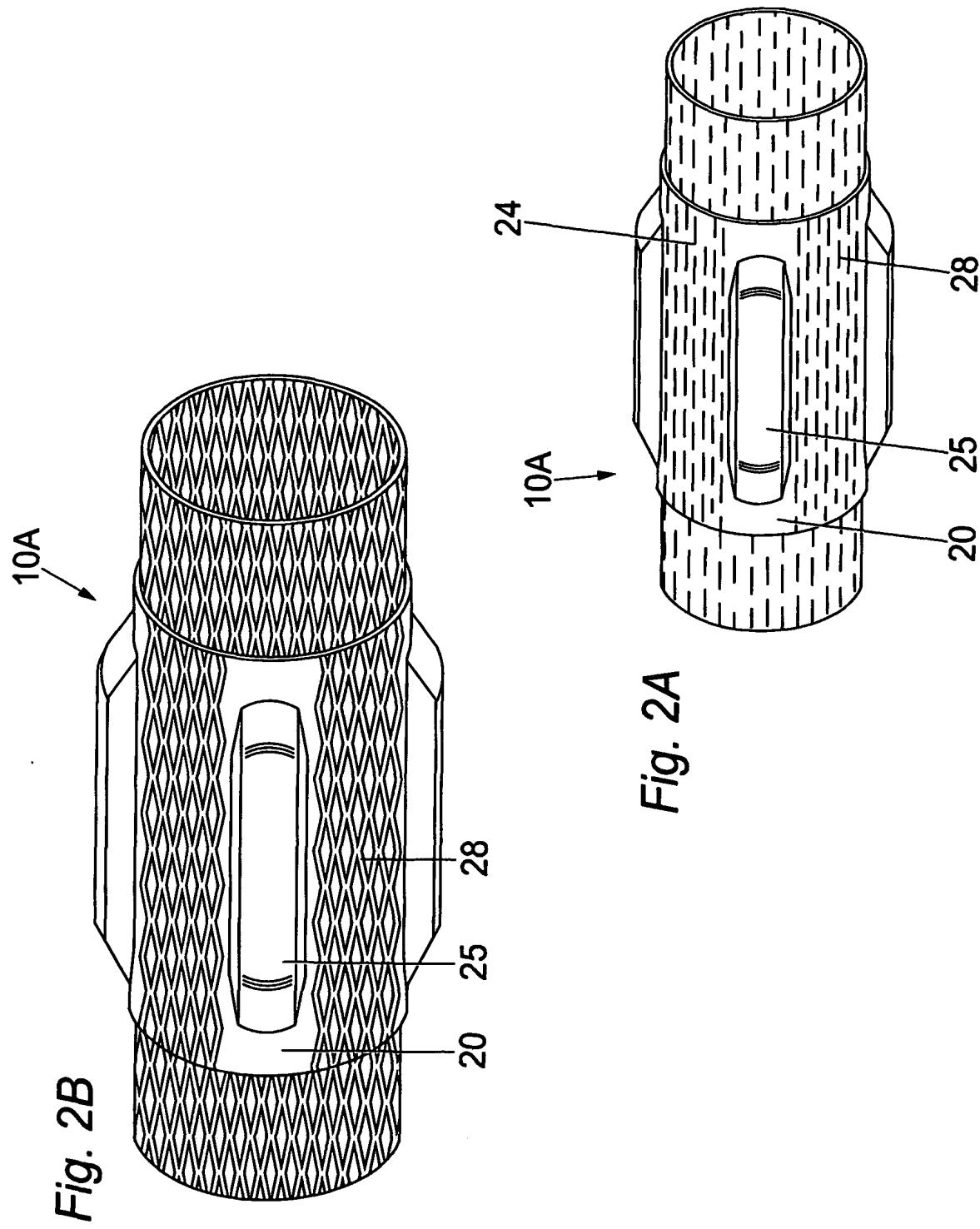
19

20 20. An assembly as claimed in claim 18 or 19,
21 wherein the tubular comprises casing, liner or a
22 screen.

1 / 2



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INTERNATIONAL SEARCH REPORT

Internat'l Application No

PCT/GB 03/01022

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B43/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHEDMinimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 358 040 A (KINLEY KARL S ET AL) 25 October 1994 (1994-10-25) column 9, line 64 - line 67 column 12, line 55 - line 59; figures 7,10 ---	1,2,10, 12,14, 17-20
P,X	WO 03 006789 A (SHELL CANADA LTD ;POINTING MICHAEL EDWARD (NL); SHELL INT RESEARCH) 23 January 2003 (2003-01-23) page 1, line 1 - line 12 figures 1-4 ---	1-4,10, 12-20
A	US 6 098 717 A (BAILEY GARY L ET AL) 8 August 2000 (2000-08-08) abstract; figures 1,2 ---	1,18 -/-

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Date of the actual completion of the international search

Date of mailing of the international search report

4 July 2003

25/07/2003

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/GB 03/01022

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6 065 500 A (METCALFE PAUL DAVID) 23 May 2000 (2000-05-23) the whole document -----	1,18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/GB U3/01022

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 5358040	A	25-10-1994	GB	2268769 A ,B		19-01-1994
WO 03006789	A	23-01-2003	WO	03006789 A1		23-01-2003
US 6098717	A	08-08-2000	AU	748646 B2		06-06-2002
			AU	9789698 A		27-04-1999
			CA	2305720 A1		15-04-1999
			GB	2345935 A ,B		26-07-2000
			GB	2368866 A ,B		15-05-2002
			GB	2368867 A ,B		15-05-2002
			GB	2368868 A ,B		15-05-2002
			NO	20001753 A		29-05-2000
			NO	20024592 A		29-05-2000
			NO	20024593 A		29-05-2000
			NO	20024594 A		29-05-2000
			WO	9918328 A1		15-04-1999
US 6065500	A	23-05-2000	AU	7848298 A		03-07-1998
			WO	9826152 A1		18-06-1998
			GB	2335689 A ,B		29-09-1999